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ABSTRACT

In this autoinstructional packet, the student is given an experimental situation which introduces him to the process of graphing. The lesson is presented for secondary school students in chemistry. Algebra I and a Del Mod System program (indicated as SE 018 020) are suggested prerequisites for the use of this program. Behavioral objectives are listed. A three hour time allotment is suggested. The equipment and materials needed are itemized. The experiment to be performed consists of two parts; Part I involves determining how to get the best out of a bunsen burner and Part II, determining the optimum distance separating flame and object heated. Data are collected for six trial runs and graphed accordingly. (FB)

ED 096 123

SE 018 023

INTRODUCTION TO GRAPHING

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TEACHER'S GUIDE

PACKET NUMBER	540.018 Sg
SUBJECT	Chemistry
TITLE	Introduction to Graphing
LEVEL	High School
BEHAVIORAL OBJECTIVES	1. Given an experimental situation, the student will record the data in a properly constructed data table as described in the lesson. 2. Given a set of appropriate data, the student will plot the data as described in the lesson.
PREREQUISITES	Algebra I and AT 540.018 S
EQUIPMENT AND MATERIALS NEEDED	Thermometer 250 ml beaker Ring, ringstand Graph paper Place in envelope 2 Metric and English ruler Place in envelope 1
TIME	3 hours
ASSESSMENTS	Questions at the conclusion of experiment
SPACE REQUIRED	Carrel and lab station

ATTENTION: TEACHERS

In this A-T are either worksheets, tests or other materials that you should duplicate or have students use an answer sheet. Please caution your students about writing on the sample.

STUDENT GUIDE

Experiment 2   Introduction to Graphing

Objectives

1. Given an experimental situation, the student will record the data in a properly constructed data table as described in the lesson.

2. Given a set of appropriate data, the student will plot the data as described in the lesson.

Assessments

Question 1 in Parts 1 and 2 of Experiment 2

SCRIPT

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In Experiment One and Optional Experiment One you made many observations. These observations can be grouped into two categories - qualitative and quanitative. When we speak of a quantitative observation we are concerned with measurement of some kind. Qualitative observations would include all others. For example, you may have listed as one of your observations, "the candle is yellow". This is a qualitative observation. "The wick is 2 cm long" is an example of a quantitative observation.

The technique that you will now work on involves the arrangement of the two types of data. The arrangement of qualitative data is rather straight-forward. It often involves listing one's observations as you did in Experiment One and Optional Experiment One. Sometimes a table of some sort can be helpful.

Most of the time you spend on this lesson will involve the recording of quantitative data, especially lists of quantitative data, and then graphing the data. Let's forget graphing for a few minutes and concentrate our efforts on the process of recording data.

The following is a list of rules that will be helpful in the recording of data:

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1. Be painstakingly neat in recording data.

2. Take data with ink or sharp pencil in final form with no intention of recopying. Any copying of original data leads to errors and might arouse suspicion that the data has been tampered with.

3. If a mistake is made in recording data cancel the wrong value with a line drawn through it leaving the original value legible.

4. The following comments refer specifically to the data table:

   a. Use a standard form of tabulation with like values in columns not rows.

   b. Data tables must be constructed before coming into the laboratory.

   c. Identify on the data sheet any apparatus used for measuring.

   d. Write at the top of the column the quantity being measured and immediately below it, the unit.

5. The data sheet should be so clear and complete that another person could take it and perform the required computations. (PAUSE)

Please go to closet A and locate the box labeled AT-2 and bring the box to the carrel. OFF In the box you will find several envelopes. Find the one labeled I and remove the contents.(PAUSE) Find the sample data table. This data was obtained by measuring the temperature of a can of oil at 8 minute intervals as it was called. Note the construction and overall appearance of the table.

Now that you have heard the rules for constructing a data table and

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have seen a sample data table it is your turn to construct a data table and record a list of data. The exercise is this: place a metric ruler alongside an English ruler and record various lengths in both centimeters and inches. (PAUSE) Probably your first inclination is to pick up the two rulers and begin measuring. Should this be your first step? (PAUSE) No! The first thing that you should do is construct your data table. Then begin obtaining and recording data. When you are finished turn the tape recorder on. OFF.

With the practice run out of the way, you are now ready to begin work on Experiment Two. The reading of this experiment was assigned at the conclusion of Experiment One. If you have not read the experiment, please read it now. Take your data tables to Station Seven and complete Experiment Two, Part One only. Do not try to answer the questions at the end of part 1 after you finish. When you do finish, turn on the tape recorder. OFF.

You now have in front of you three sets of data. By looking at the data in its present form you should be able to determine which of the three adjustments results in the most rapid heating of water. Simply see which trial took the smallest amount of time. (PAUSE) Even though you know the answer from looking at your data table and it may not seem necessary, we will now introduce a much better way to

arrange your data, a way that makes interpretation of data both easier to see and more meaningful. The technique is called graphing. One only needs to pick up a scientific journal, or for that matter the evening newspaper and one will often find data expressed graphically. In Envelope I you will find some articles that have appeared in scientific journals. Leaf through the articles and in observing the graphing, I think that you will begin to see that graphing is an ideal way of representing data. When you are finished looking at the articles turn on the tape recorder. OFF.

You are probably somewhat familiar with graphing from previous science and math courses. However, since you will be constructing and interpreting graphs throughout this course, it will be worthwhile to review some ideas involving graphing that you may already know and at the same time discuss some aspects of graphing that may be new.

There are many types of graphs which can be categorized in many ways. We will separate them into two groups - theoretical and experimental. First we will look at the type of graphing that you encounter in your math classes - the theoretical relationship. There you begin with an equation relating t) variables. You then substitute arbitrary values of one variable into the equation and solve for the other variable. Look at the examples of this type of graph that are in

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Envelope II. OFF. You should be able to identify the three types of relationships, however, at this time we will not go into an analysis of them.

The second type of graphing involves constructing graphs using values that have been experimentally determined. It is this type of graph that you will be constructing throughout this course.

Before going into the actual construction of a graph, let's first get at the basic idea behind the graph. To illustrate look at Figure 1. (PAUSE) What is the total number of values listed in the table of values of this graph? (PAUSE) There are ten, five values of X and five corresponding values of Y. Now look at the graph. How many points have been plotted? (PAUSE) There are five. The whole idea in a graph is to simultaneously represent <u>two</u> related values with <u>one</u> point. We can then see the simultaneous change that takes place in the two variables by looking at the shape of the graph. For example, we can see by looking at the graph on Figure 1 that as X increases, Y increases.

What then is necessary in plotting a graph? 1. a set of data. 2. an appropriate coordinate system. You already have several sets of data in front of you. So let's get at the concept of a coordinate system. One constructs a coordinate system by drawing two lines perpendicular to each other. Remove the contents of Envelope III and

look at Figure 4. This is referred to as a rectangular coordinate system. There are other types of coordinate systems but they are not necessary in plotting data obtained in this course. The two lines are called axes. The horizontal axis is called the abscissa, while the vertical axis is called the ordinate. The four regions formed by the intersection of the axes are called quadrants and each is numbered as indicated on Figure 4. The point of intersection is called the origin.

Two variables may be represented on this coordinate system, one on the abscissa and the other on the ordinate. Positive values are represented to the right of the origin on the abscissa and negative values are represented on the left side. To illustrate, three values of variable Q are plotted on the abscissa in Figure 4. (PAUSE) Positive values on the ordinate are plotted above the origin while negative values are plotted below the origin. To illustrate three values of variable Z are plotted on the ordinate in Figure 4. (PAUSE)

Now let's follow the step by step process of plotting a graph. Obtain the data table that was referred to earlier in this lesson, the one involving the cooling of a can of oil. (PAUSE) What about a coordinate system? Should we construct one like the one shown in Figure 4? (PAUSE) We could, but if you look closely at the data you

will see that it contains no negative values. This means that we will probably need only the first quadrant. Although there are times when all four quadrants should be constructed this is not one of them. Since we only need the first quadrant, this is all that we need to draw. Refer to Figure 5. (PAUSE) It is then wise to slightly darken every tenth line along each axis. See Figure 6. (PAUSE) Next we must label our axes. By convention the independent variable is plotted on the abscissa while the dependent variable is plotted on the ordinate. In this case the temperature depends on time so temperature is dependent variable while time is the independent variable. Now we can label the axes. Each axis must be labeled with the name of the quantity plotted and its unit separated by a comma. See Figure 7. (PAUSE) The graph must have a title which tells more than the labels of the axes. See Figure 7. (PAUSE)

The next step is to choose scales for our axes. Scale selection involves deciding what value to assign each division of the axis. One should choose scales for the main division that are easily subdivided. Values of two, five, and ten are best. Four and eight may be used in some cases. Three, seven and nine should rarely be used. The scale should be chosen so that when points are plotted the graph fills most of the page. Note on Figure 7 that the scale on the ordinate and the abscissa are not the same. On a given graph the

scales on the 2 axes may be the same but this is certainly not necessary.

We are finally ready to plot our points. The first value taken was a temperature of 200°F at 0 min. We locate the two values on our axes and carefully plot the point. Then circle it. See Figure 8. (PAUSE) This point is said to have the coordinates 200, 0. The coordinates are sometimes placed in the vicinity of the point. See Figure 8. (PAUSE) We continue plotting points until all values are plotted. See Figure 8. At last we get to connect the points, or more appropriately draw the best curve through the points. See Figure 9. (PAUSE) Notice, we do <u>not</u> connect pairs of points with straight lines as in Figure 10. (PAUSE) This important idea of drawing a smooth curve through the points is better illustrated with data which is not as good as the sample data given to you. Look at Figures 11 and 12. (PAUSE)

Here the points are not nearly as good as those in Figures 9 and 10. Figure 12 illustrates the correct way to connect the points, whereas Figure 11 illustrates the wrong way. (PAUSE) Now let's see how you can do. Get out your data on different lengths measured in inches and centimeters. Obtain a piece of graph paper from Envelope IV and graph your data. Remember to use the example as a guide. When you are finished turn on the tape recorder. OFF.

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That wasn't too hard was it? Envelope V contains a graph of the same type of data you used. (PAUSE) The numbers are different but the result should be the same - a straight line passing through the origin. If you have any questions, ask your teacher before going on.

You are now ready to answer questions 1 and 3 of Part 1, Experiment 2. When you finish the questions, go on and do Part 2, Experiment 2. Then do questions 1-5, skipping number 2 at the end of Part 2.

When you are finished, return all materials to where you found them. Rewind the tape.

The completed lab report is due tomorrow.

EXPERIMENT 2

OBSERVING THE LABORATORY BURNER

Introduction

The general purpose of this experiment is to make one familiar with the laboratory burner, its mechanical workings, and its use as a source of heat. The experiment consists of two parts, Part I involves determining how to adjust the air intake for the purpose of getting the hottest possible flame. Part II involves determining the optimum distance between the top of the burner and the bottom of the beaker of water being heated to boiling. The procedure followed in making these determinations involves measuring the rate at which a beaker of water is heated to boiling. You will begin with water at slightly below room temperature (20°C). You will then heat the water with your burner and measure the temperature of the water at 30 second intervals until boiling begins and continues for about one minute. You will then plot your data on the graphs. From your graphs you will then calculate the rate of heating with the different adjustments of the apparatus. From a comparison of these rates, you will know how to make most efficient use of your laboratory burner.

Procedure for Part I

A. Lighting the burner and observation of the flame

1. Connect your burner to a gas outlet, open the gas valve about half-way, and light the burner from the side as

shown in Figure 1. Describe the flame produced when the air intake of the burner is open (adjust the barrel to a distance of 3 mm from the closed position) Figure 2.

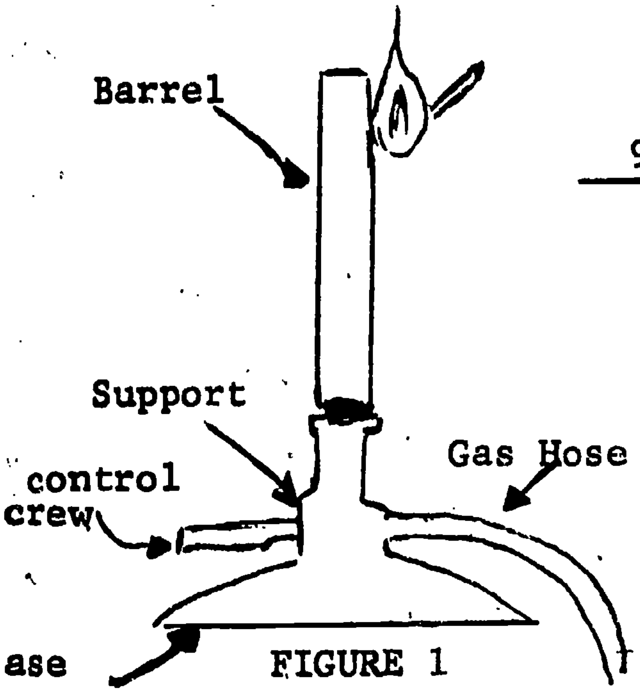

FIGURE 1

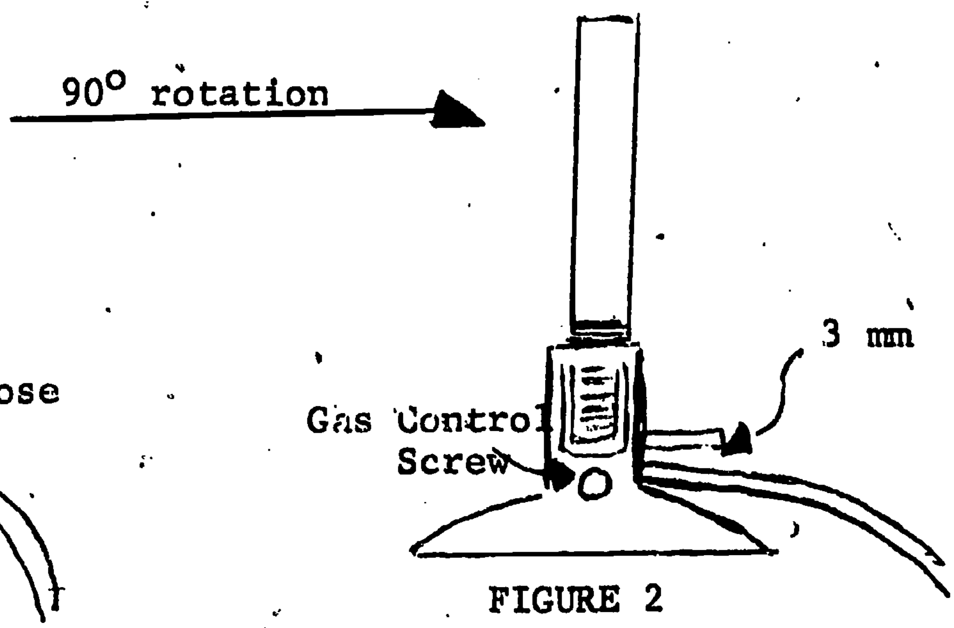

FIGURE 2

2. Using a glove, turn the barrel of the burner clockwise until it comes in contact with the support. Describe the flame produced.
3. Slowly turn the knob on the base of the burner. Describe the effect on the flame.
4. Turn the burner off.

B. Effect of the air intake on the hotness of the flame

1. Place your burner on the base of a ringstand. Place a 10 cm iron ring on the ringstand so that the distance between the top of the burner and the ring is between

5 and 10 cm.

2. Using a graduated cylinder, measure 100 ml of cool tap water (run the water for about one minute before you begin measuring) into a clean dry 250 ml beaker.

3. Take the burner aside and light it. Be sure the air intake is still closed. Light the burner. Turn the gas valve on the gas outlet to maximum and adjust the flame with the gas control, screw on the burner to give about 1/3 to 2/3 maximum gas supply.

4. Place a wire screen on the iron ring and place the beaker(with water) on the center of the screen. Take the temperature of the water (to the nearest .1°C). At a convenient starting time place the lighted burner directly beneath the center of the beaker. Figure 3. Stir the water gently with a thermometer. Read and record the temperature of the water every 30 seconds until vigorous boiling proceeds for about one minute. Mark the position of the burner on the base of the ring stand (use chalk). Remove the burner. You may turn it off but be sure to use the valve at the gas outlet. Do not turn off the burner using the gas control screw on the burner. Why?

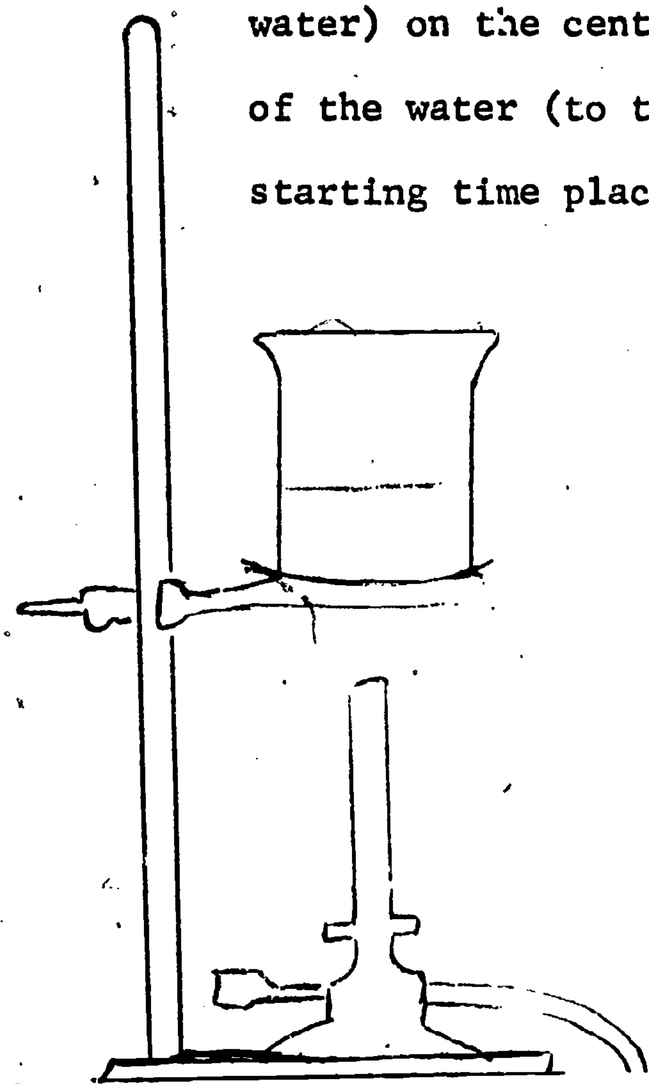

FIGURE 3

EXPERIMENT 2

5. Using beaker tongs pour the hot water into the sink. Avoid getting fingers into the hot water. Rinse the beaker with cold water. Douse the hardware in cold water. Wipe dry with paper towels. All apparatus should come to about the same temperature as that at the start of the experiment - room temperature.
6. Repeat Part B, 1-5, with the barrel adjusted first to 2 mm and then at 4 mm from the closed position.

Please return all materials to where you found them. Go to the carrel and turn on the tape recorder.

Questions for Part I

1. Plot the three sets of data on the same side of your graph paper on the same coordinate system.

2. Determine the rate of heating for each trial by calculating the steps of each curve.

3. How should the air intake be adjusted for the most rapid heating of water?

Procedure for Part II

Repeat the general procedure described in Part 1B with the following changes and additions:

1. Adjust the barrel to the optimum position as determined in Part I.

EXPERIMENT 2

2. After adjusting the barrel and rate of flow of gas, sketch a picture of the flame.

3. Run six trials with distance between the top of the burner and the bottom of the beaker being 3,5,7,9,11, and 13 cm.

4. In addition to recording temperature - time data for each trial, indicate on your drawing of the flame, the lowermost region of the flame that comes in contact with the bottom of the beaker.

Questions for Part II

1. Plot the six sets of data on the same side of your graph paper on the same coordinate system.

2. Determine the rate of heating for each trial by calculating the slope of each curve.

3. With the flame adjusted as it was in your experiment, what is the optimum distance between the top of the barrel and the bottom of the beaker for heating water?

4. What region of the flame was in contact with the bottom of the beaker for the trial that gave you the fastest rate?

5. When using the burner in the future, would it be better to remember your answer for question 3 or question 4? Explain.

DATA TABLE EXPERIMENT 7

Time, min	Temperature, ^{o}F
0	200
8	121
16	77
24	52
32	38
40	30